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Possible Ontogenetic Change in the Radula of *Conus patricius* of the Eastern Pacific

by

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Abstract. The eastern Pacific *Conus patricius* is a distinctive cone that shows a possible ontogenetic change in the radula tooth morphology. Smaller specimens have a very small juvenile tooth which lacks the barb, blade, and serration of the adult. At this time, the change can be weakly correlated only with size or age of the species.

INTRODUCTION

The prosobranch gastropod radula is known to show a certain amount of morphological variability within a species (BANDEL, 1974; BORKOWSKI, 1975; CARRIKER, 1943; CERNOHORSKY, 1970; HOWE, 1930; MERRIMAN, 1967; ROSEWATER, 1970; HOUBRICK, 1978). This variability has been most often correlated with sex (ROBERTSON, 1971; MAES, 1966; ARAKAWA, 1958, 1969), and virtually all studies have dealt with adult radulae. Until recently, no studies appear to have followed the ontogenetic development of the prosobranch radula between postmetamorphic juveniles and adults. Such ontogenetic change was recently reported for *Epitonium billeeana* by PAGE & WILLAN (1988) and for *Conus magus* by NYBAKKEN & PERRON (1988). In the case of *C. magus,* the change was correlated with diet, as the adult is a piscivore and the juveniles are too small to consume fish. In *E. billeeana,* a protandric hermaphrodite, the radula morphology changed when the individuals changed sex.

In the course of a comparative radula study of West American species of *Conus,* NYBAKKEN (1970b) uncovered a difference in the radulae of what were believed to be adult and juvenile *Conus patricius* (Hinds, 1843). At that time, a paucity of specimens precluded a more extensive study of the radula of *C. patricius* to confirm or deny the original single observation. Since that time, additional specimens have become available, which now establish the possible occurrence of an ontogenetic change. It is the purpose of this paper to document this change and to suggest the reasons for its occurrence.

MATERIALS AND METHODS

Specimens of *Conus patricius* were obtained from the 1967 Pillsbury Expedition to the Gulf of Panama (NYBAKKEN, 1971), the Los Angeles County Museum, the Academy of Natural Sciences of Philadelphia, and from the personal collection of Mr. Alex Kerstitch. From these collections, a total of nine specimens yielded radulae which could be analyzed. These specimens ranged in shell length from 27.1 to 83.5 mm. The geographical range was from the Sea of Cortez to the Gulf of Panama.

Each individual was measured with vernier calipers for total shell length and width at the widest part of the shell. The animal was then extracted and the radula sac dissected out. The radula sac was transferred to a depression slide, where the teeth were freed from the soft tissue by dissolving the latter in a 5.25% sodium hypochlorite solution. Freed radula teeth were washed in two rinses of water and mounted directly from water into polyvinyl lactophenol on glass slides. Radulae were examined under a compound microscope equipped with a differential interference contrast system after Nomarski. Drawings of the individual teeth were made using a drawing tube.

In addition to the above specimens, Dr. Alan Miller provided slides of the gut contents of two specimens of *Conus patricius* that had been taken in Panama. In this latter case, the specimens were not seen.

Descriptive terminology in the description of the radula tooth follows NYBAKKEN (1970b) and KOHN *et al.* (1972).

RESULTS

Of the nine *Conus patricius* dissected, four were male, four female, and one could not be assigned to a sex. With one exception, all of the smaller individuals were female and all of the larger, male. The exception was an 83.5 mm female.

Two distinct types of radula teeth were observed (Figure 1). The juvenile tooth was found in four specimens in

which the shell length ranged from 27.1 to 53.4 mm. The adult tooth was found in five specimens that ranged in size from 59.9 to 83.5 mm. Both radula types included males and females.

The adult tooth (Figure 1A) is elongate and characterized by a structure in which the serration is long relative to the lengths of the barb and blade and terminates in a rounded cusp about halfway down the shaft. There is virtually no waist. Each tooth is surmounted at the distal end by a short, pointed barb on one side, opposed by a truncated, short blade on the other. The adult tooth is similar to those of *Conus fergusoni* and *C. princeps*.

The juvenile tooth (Figure 1B) is very different. It is proportionately much smaller in size, and there is no indication of barb, blade, or serration. The basal, or proximal, part of the shaft is thicker than the distal part. There is also a very large opening to the central lumen.

Feeding data for *Conus patricius* are very sparse. The only information available was contained in the two slides of gut contents from adult-sized cones that were received from Dr. Alan Miller. Both slides had polychaete setae on them. One had the setae of the family Aphroditidae, and the other had setae of the families Aphroditidae and Spionidae. The radula condition of these specimens is unknown. The adult radula of *C. patricius* is very similar to that of *C. princeps*, which consumes polychaetes (Nybakken, 1979), so it is not surprising that polychaete remains were also found in *C. patricius*.

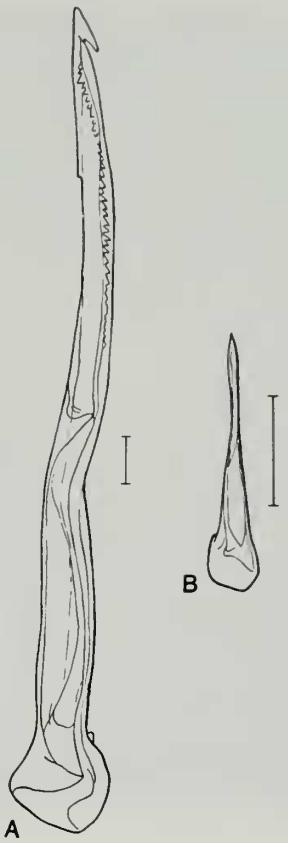

Figure 1

A. The radula of an adult *Conus patricius*. B. The radula of a juvenile *Conus patricius*. The length of the scale bar is 0.1 mm for both figures.

DISCUSSION

Although the number of individuals is small (n = 9), a number of factors strongly suggest that there is a decided ontogenetic change that occurs in the radula of *Conus patricius*. In the first place, *C. patricius* is a very distinctive cone. The characteristic pyriform shape is found in both the juveniles and adults and in no other eastern Pacific congeners (Figure 2). Therefore, it appears that we are not dealing with two species, one small and one large. This is reinforced by the finding of two similar-sized individuals, one 53.4 mm long and the other 59.9 mm long. The 53.4 mm individual, a male, possessed the juvenile radula and the 59.9 mm individual, also a male, the adult radula (Figure 2). Both individuals were collected in the same locality at the same time.

This case of two specimens of almost the same size having different radulae also suggests that the radula change, when it occurs, must be rapid. This is supported by the finding, in *Conus magus*, that an intermediate radula tooth type occurred only in specimens within a 3-mm size range (Nybakken & Perron, 1988).

The change in radula is not due to sex, since among the nine specimens, adult and juvenile radulae were found in both females and males.

The juvenile tooth of *Conus patricius* is almost identical to the juvenile radula tooth of *C. magus* (Nybakken & Perron, 1988). However, as an adult, *C. magus* is a piscivore; whereas, from our limited evidence here, we presume *C. patricius* as an adult is a vermivore. Similarity in morphology between the juvenile teeth of species in which adult teeth and diet are very different suggests that both juveniles could have similar diets, but this contention cannot now be answered because of lack of dietary information for juvenile *C. patricius*. Nybakken & Perron (1988) have, however, demonstrated that juveniles of *C. magus* consume polychaetes of the family Syllidae. If tooth morphology is correlated with diet in this case, as it is in some *Conus* (Lim, 1969; Nybakken, 1970a), it could be that the juveniles of these much larger cones are also eating syllids or other small polychaetes.

While I have established that there is a change in tooth structure in *Conus patricius*, I cannot correlate it with diet and can only very weakly correlate it with size or age. Nor can I demonstrate how the change might come about. I can, however, offer some speculation. Marsh (1977) demonstrated that, in the radula development of the adults of several species of *Conus*, each tooth is formed initially by odontoblasts and then finished and hardened by a tissue called the superior epithelium. It is therefore possible that

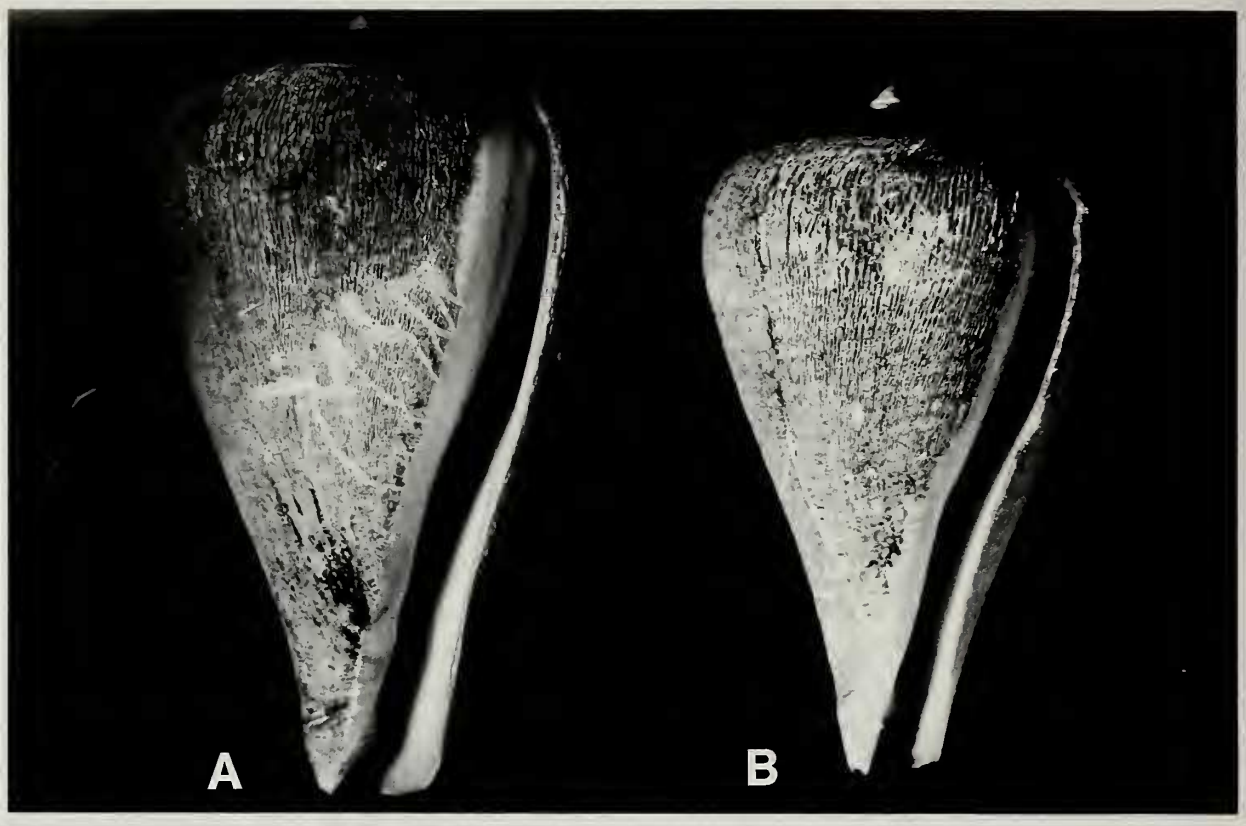

Figure 2

A. A specimen of *Conus patricius,* 59.9 mm in shell length, which contained an adult radula. B. A specimen of *Conus patricius,* 53.4 mm in shell length, which contained a juvenile radula.

in juvenile *C. patricius,* and perhaps other *Conus* as well, only the odontoblasts are first active, and they secrete the initial or juvenile tooth. Then later, when the animal is larger and ready to change diet, the superior epithelium is activated and the adult tooth is formed.

LITERATURE CITED

ARAKAWA, K. Y. 1958. On the remarkable sexual dimorphism of the radula of *Drupella*. Venus 19:206–214.

ARAKAWA, K. Y. 1969. On some problems of sexually dimorphic radulae. Venus 28:125.

BANDEL, K. 1974. Studies on the Littorinidae from the Atlantic. Veliger 17(2):92–114.

BORKOWSKI, T. V. 1975. Variability among Caribbean Littorinidae. Veliger 17(4):369–377.

CARRIKER, M. R. 1943. Variability, developmental changes and denticle replacement in the radula of *Lymnaea stagnalis appressa* Say. Nautilus 57(2):52–59.

CERNOHORSKY, W. O. 1970. Systematics of the families Mitridae and Volutomitridae (Mollusca: Gastropoda). Bull. Auckland Institute and Museum No. 8:iv + 190 pp., 18 pls.

HOUBRICK, R. S. 1978. The family Cerithiidae in the Indo-Pacific. Part I. The genera *Rhinoclavis, Pseudoverlagus,* and *Clavocerithium*. Monogr. Mar. Mollusca 1:1–130.

HOWE, S. W. 1930. A study of the variations in the radula of a snail with particular reference to the size of the median teeth. Nautilus 44(2):53–56.

KOHN, A. J., J. NYBAKKEN & J. J. VAN MOL. 1972. Radula tooth structure of the gastropod *Conus imperialis* elucidated by scanning electron microscopy. Science 176:49–51.

LIM, C. F. 1969. Identification of the feeding types in the genus *Conus* Linnaeus. Veliger 12(2):160–164.

MAES, V. O. 1966. Sexual dimorphism in the radula of the muricid genus *Nassa*. Nautilus 79:73–80.

MARSH, H. 1977. The radular apparatus of *Conus*. Jour. Moll. Stud. 43:1–11.

MERRIMAN, J. A. 1967. Systematic implications of radular structures of West Coast species of *Tegula*. Veliger 9(4):399–403.

NYBAKKEN, J. 1970a. Correlation of radula tooth structure and food habits in three vermivorous species of *Conus*. Veliger 12(3):316–318.

NYBAKKEN, J. 1970b. Radular anatomy and systematics of the west American Conidae (Mollusca, Gastropoda). Amer. Mus. Novitates No. 2414:29 pp.

NYBAKKEN, J. 1971. The Conidae of the Pillsbury Expedition to the Gulf of Panama. Bull. Mar. Sci. 21(1):93–110.

NYBAKKEN, J. 1979. Population characteristics and food resource utilization of *Conus* in the Sea of Cortez and west Mexico. Jour. Moll. Stud. 45:82–97.

Nybakken, J. & F. E. Perron. 1988. Ontogenetic change in the radula of *Conus magus*. Mar. Biol. 98:239–242.

Page, A. J. & R. C. Willan. 1988. Ontogenetic change in the radula of the gastropod *Epitonium billeeana* (Prosobranchia: Epitoniidae). Veliger 30(3):222–229.

Robertson, R. 1971. Sexually dimorphic archaeogastropods and radulae. Ann. Rept. Amer. Malacol. Union for 1970: 75–78.

Rosewater, J. 1970. The family Littorinidae in the Indo-Pacific. Part 1. The subfamily Littorninae. Indo-Pacific Mollusca 2(11):417–479.